Oct. 27, 1970 C. T. FRIZELL 3,535,905

RECTILINEAR EDGE FLANGING TOOL FOR SHEET METAL WORKPIECES

Filed Jan. 23, 1968 3 Sheets-Sheet 1

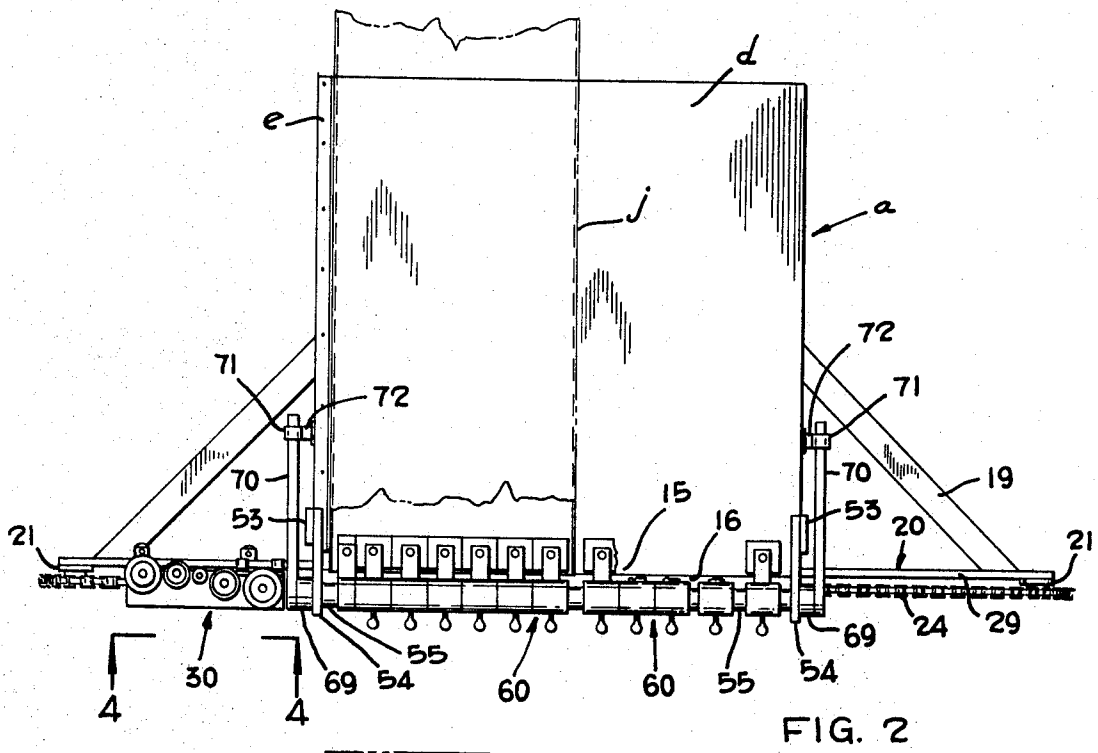


FIG. 2

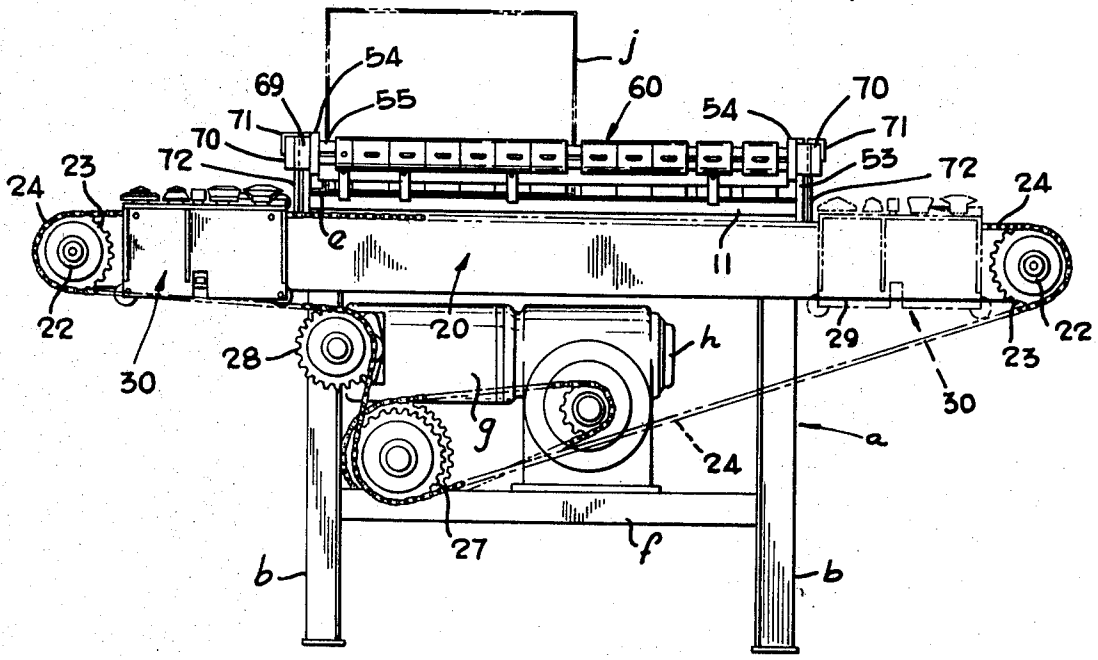


FIG. 1

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Filed Jan. 23, 1968 3 Sheets-Sheet 2

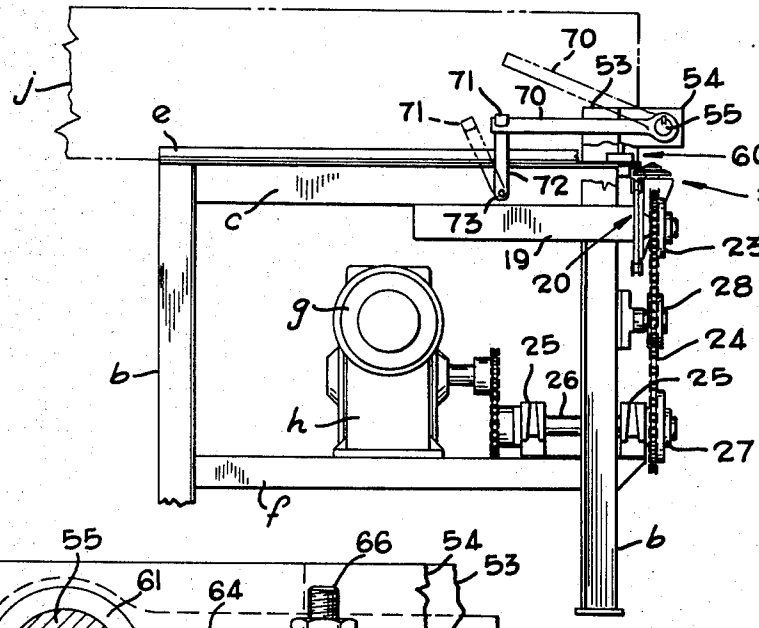


FIG. 3

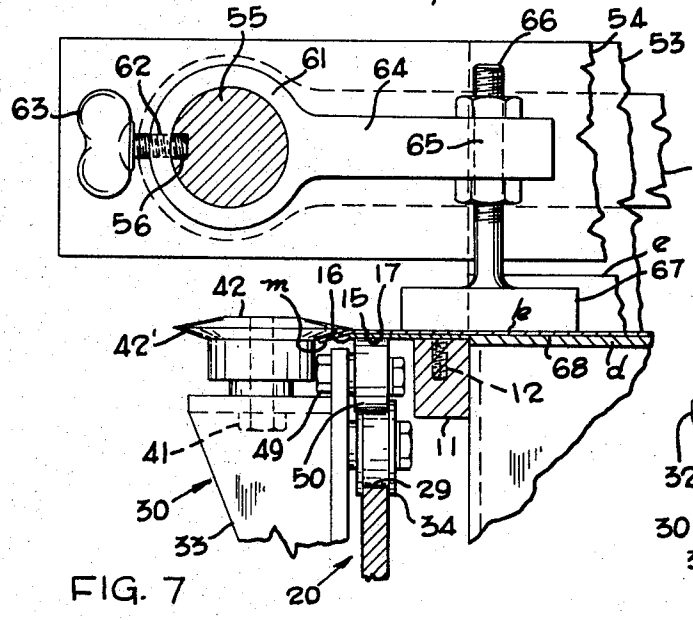


FIG. 7

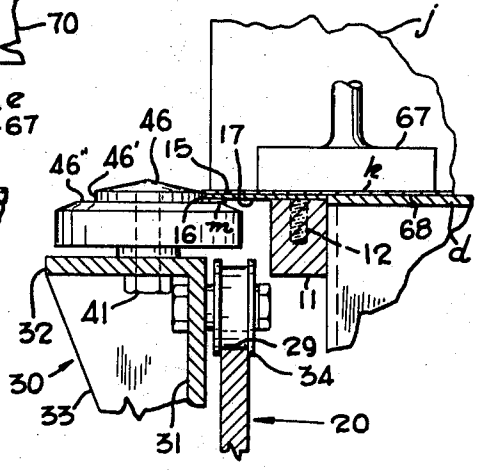


FIG. 8

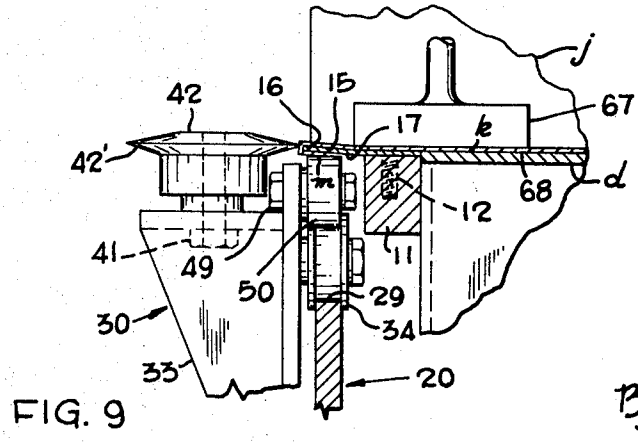


FIG. 9

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RECTILINEAR EDGE FLANGING TOOL FOR SHEET METAL WORKPIECES

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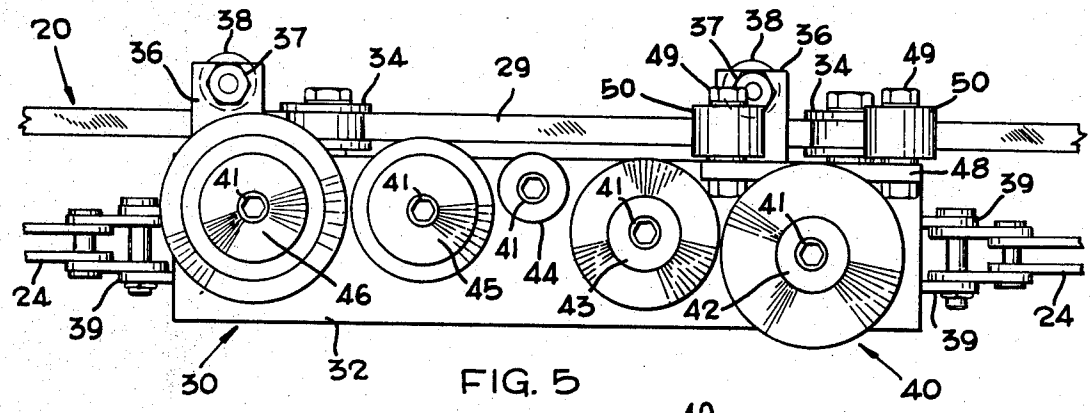


FIG. 5

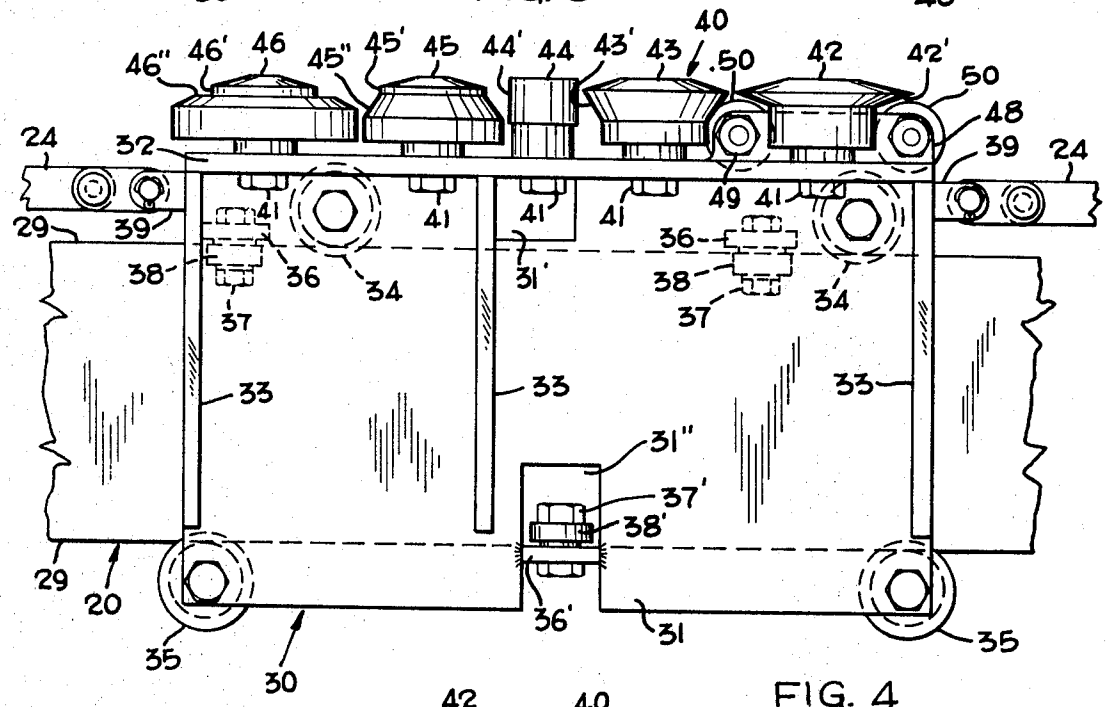


FIG. 4

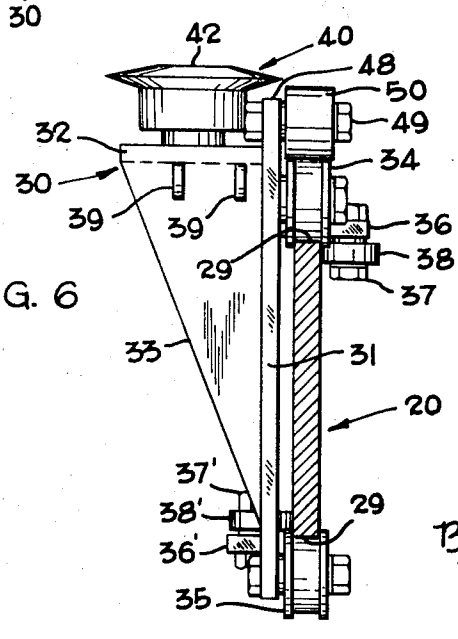


FIG. 6

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United States Patent Office 3,535,905 Patented Oct. 27, 1970

3,535,905

RECTILINEAR EDGE FLANGING TOOL FOR SHEET METAL WORKPIECES

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Int. Cl. B21d 19/06
U.S. Cl. 72—220 7 Claims

ABSTRACT OF THE DISCLOSURE

A flanging tool for turning 180° edge flanges, especially suited for the ends of sheet metal ducts, includes a table surface with a blade-like projecting forming edge, an outboard clamp mechanism, and a longitudinal track. A traversing carriage, mounting a plurality of forming rolls which work against the projecting table edge, turns a flange downwardly, around and upwardly beneath the edge. Adjacent to the downward-forming rolls, are rolls beneath the projecting edge which support the edge on the forming stroke. On the return stroke, these rolls press out the flange more tightly against the under surface of the edge.

This invention relates to rectilinear edge flanging tools for sheet metal workpieces, and particularly to the tools for turning 180° flanges on the ends of sheet metal duct sections.

The problem, exemplified in the construction of sheet metal ducts for air conditioning systems and the like, is that such 180° flanges must usually be formed on two opposite edges of a seamed rectilinear duct. Adjacent duct sections with such 180° flanges, are joined by flattened C-shaped "drive cleats." Unless the 180° flanges are smooth and precise, such drive cleats cannot be readily attached.

A machine adapted to form such flanges by folding is shown in U.S. patent to Engel and Mace No. 2,973,796. The machine there disclosed forms the 180° bend by a folding operation; if large widths of duct are to be accommodated, the major machine elements must be made broad enough to accommodate them; and a machine of modest size has limited utility. It is common to form such 180° bends with hand tools; this can be accomplished successfully only by someone with substantial skill and experience.

SUMMARY OF THE INVENTION

One of the purposes of the present invention is, while holding a workpiece in fixed position, to turn a flange by a traversing roll mechanism, this may be the same regardless of the width of the workpiece to be flanged; only the length of its travel need be changed. Other purposes are to so roll an edge flange as to achieve a tight 180° bend without appreciable spring-back, and to press the flange so formed flat and even. A further purpose is to utilize both traversing and return movements of the roll carriage to accomplish the forming operation.

Generally summarizing (and without limitation), the present invention includes a workpiece support structure having a rectilinear forming edge which projects therefrom in a plane; workpiece securing means such as a clamp mechanism including adjustably-spaced clamp pads actuated from outward of the forming edge and projecting thereover (e.g., into the end of a duct to be flanged); a track parallel to and below the level of the forming edge; a carriage mounted thereon; means to draw the carriage along the track in a forming movement and to return it in a return movement; forming rolls carried by the carriage to bend the edge of a workpiece into a flange

downward, around and beneath the projecting forming edge; and means, such as rolls on the horizontal axis, mounted on the carriage beneath the level of the projecting edge, to support the projecting edge against the pressure of the downward-forming rolls and, on the return movement of the carriage, to press and flatten the formed flange against the under surface of the edge.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of an edge flanging tool of the embodying invention, with the carriage in position for a forming stroke. The phantom lines show the carriage position prior to its return stroke; also a sheet metal duct in position for flanging.

FIG. 2 is a plan view thereof.

FIG. 3 is a view thereof from the left end of FIG. 1, the clamp mechanism being in raised position, its lowered and locked position being shown in phantom lines.

FIG. 4 is an enlarged elevational view of the carriage as seen along line 4—4 of FIG. 2.

FIG. 5 is a plan view of the carriage.

FIG. 6 is a right end view thereof.

FIG. 7 is a schematic view showing the initial downward forming operation achieved by the first forming roll, at the right end of FIG. 4.

FIG. 8 is a view of the final forming operation achieved by the forming roll at the left end of FIG. 4.

FIG. 9 is a fragmentary view illustrating the upward pressing operation on the return stroke of the carriage.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1, 2 and 3, a workpiece support structure generally designated *a*, preferably formed by welding, includes four upright legs *b* and horizontal top surface supports *c*, onto which are secured a steel table surface *d* with a gage bar *e* along its left edge. Lower horizontal braces *f* support an electric motor *g* and gear reducer *h*, hereinafter referred to.

Secured, as by bolting, along the forward side of the table surface *d*, immediately below its level, is a rigid rectangular support bar **11**, as shown in FIGS. 7 and 8. To its upper surface is secured, by counter-sunk screws **12**, a blade-like projecting forming edge **15** which extends the full length of the table surface *d* and whose upper surface is co-planar with it. The outer edge **16** of the forming edge **15** serves as the edge about which the 180° flange is to be formed, as hereinafter described; a projecting portion **17** of its under surface outwardly of the support bar **11** is utilized in the manner hereinafter described.

The forming edge **15** is preferably formed of steel having spring-like resilience, which permits it to withstand the forces of the forming operation and to deflect slightly, as required in the operation hereinafter to be described, especially where variation in thickness of sheet metal workpieces must be accommodated.

At a level below the forming edge **15**, and mounted at its ends on welded girders **19** which extend diagonally forward from midpoints of the side horizontal table supports *c*, is an elongated vertical plate which constitutes the carriage track, generally designated **20**. As will be seen from FIGS. 1 and 2 it extends parallel to the edge **15** and is sufficiently longer than the table surface *c* to accommodate a carriage, generally designated **30**, on either side thereof, and still farther outwardly, to be reinforced by reinforcing plates **21** in which bearings **22** having forward-and-aft axes are supported. On these bearings **22** are mounted a pair of sprockets **23** over which passes a carriage drive chain **24**.

The chain **24** is powered as follows: in addition to the motor *g* and gear reducer *h* there are mounted on the

lower braces *f* a pair of pillow blocks **25** which support a drive shaft **26**, chain-driven reversibly by the gear reducer *h* and having an outer driving sprocket **27** which engages the carriage drive chain **24**. An adjustable tension sprocket **28** supported adjacent to one of the legs *b* completes the driving assembly, as shown in FIGS. 1 and 3.

The carriage track **20** has horizontal upper and lower edges **29** on which the carriage generally designated **30** is mounted. As best seen in FIGS. 4, 5 and 6 the carriage **30** consists of a vertical plate **31** having upper and lower edge cut-outs **31'** and **31''**. The plate **31** has at its outer side a narrow horizontal forming roll support shelf **32**, stabilized by three triangular ribs **33**. Bolted to project to the inner side of the plate **31** are upper grooved rollers **34** and lower grooved rollers **35**. On welded lugs **36**, which project horizontally inward adjacent to the upper rollers **34**, are vertical bolts **37** bearing two inner guide rollers **38**; these are positioned inwardly of the track **20**. Somewhat similarly, in the lower cut-out **31''** is welded a horizontal lug **36'** bearing a vertical bolt **37'** on which is mounted an outer guide roller **38'**.

A pair of lugs **39** welded to the support shelf **32** outwardly of each of the end ribs **33** serves to attach the chain **24** to the carriage **30**, whereby the driving assembly heretofore described serves as means to draw the carriage along the track **20**. The motor *g* being of the reversible type, operated by conventional controls (not shown), the carriage **30** may be traversed initially for a forming stroke from the solid line position shown in FIG. 1 to the phantom line position, and thence returned on a return stroke.

Mounted along the support shelf **32** of the carriage **30** are a series of progressive forming rolls generally designated **40**, each being free to rotate on a vertical bolt **41**. In the embodiment illustrated, five such progressive forming rolls **42, 43, 44, 45, 46** are utilized. As shown in the schematic views FIGS. 7 and 8, these are located in workpiece forming adjacency to the rectilinear forming edge **15**. When the carriage **30** is drawn along the track **20**, the vertical bolts **41** describe planes which are substantially perpendicular to the support plane of the table surface *d*.

The configurations of the progressive forming rolls **42–46** are adapted, in relation to the projecting edge **15**, to form a flange progressively downward and around and thence upwardly under the blade edge **15**. Specifically, the first progressive forming roll **42**, illustrated at the right side, includes a forming surface of revolution **42'** inclined downwardly from the forming edge **15** and outwardly toward its mounting bolt **41**. This forming surface of revolution **42'** extends partly above and partly below the support plane defined by the table surface *d*. The next forming roll **43** includes a forming surface of revolution **43'** inclined downward at a greater angle; the third roll **44** includes a vertical forming surface of revolution **44'**. These forming surfaces of revolution **42'**, **43'**, **44'** are, at the level of the forming edge **15**, spaced forward of its outer edge **16** sufficiently to accommodate a thickness of the workpiece to be formed. The fourth of the progressive forming rolls **45** has a similarly located surface portion **45'** adapted to control the point at which the flange is formed downwardly, and also includes a larger forming surface of revolution **45''** therebeneath which is directed inwardly beneath the under surface **17** of the forming edge **15**. This inwardly directed surface **45''** therefore commences the forming of the flange upwardly against the under surface **17**. Such upward forming is brought to 180° at the forming roll **46** by its upwardly presented surface of revolution **46''**, while its vertically presented surface of revolution **46'** continues to control the point of flanging, as best seen in FIG. 8.

At the forward end of the carriage (the right side as viewed in FIG. 4) the plate **31** has an upward projecting portion **48** in which are mounted, on horizontal axes forward and aft of the first forming roll **42**, bolts **49** which serve as axes for a pair of edge support rolls **50**; these

extend aft immediately beneath the under surface **17** of the forming edge **15**, as best shown in FIG. 7. As the carriage **30** is drawn along the track **20**, the bolts **49** define a plane parallel to the edge under surface **17** spaced sufficiently beneath it to provide for its passing support by the upper surface of the rolls **50**. Alternately, other forming edge support means, such as a block of material having a lubricated surface, might be used to overcome the downward deflection of the forming edge **15** under the downward bending force applied by the roll **42** in the manner shown in FIG. 7 and similarly by the next forming roll **43**. The spacing of the edge support rolls **50** adjacent to the downward forming rolls **42, 43** but forward of the inward forming rolls **45, 46** avoids interference with the edge of the workpiece as it is subsequently flanged inward.

A clamp mechanism is provided to secure a workpiece, such as the open end of a sheet metal duct *j*, to the table surface *d*. At the forward or working side of the apparatus, immediately above the left and right legs *b* are welded upward extension plates **53**, at whose upper ends are forward extending plates **54**, bored to provide aligned pivot mounts for a clamp bar **55**, outwardly of the forming edge **15** and parallel thereto and above the level of the track **20** and carriage means **30**. As best seen in FIG. 7, the clamping bar **55** has a keyway **56**. Along its length between its pivot mounts in the plates **54** are a plurality of spaced-apart clamp pads generally designated **60**. Each includes a sleeve portion **61** fitted slidably on the bar **55** and having a tapped bore **62** accommodating a wing bolt **63** by which it is secured to the bar **55**. Each clamp pad **60** also has a rigid arm portion **64** which extends over and inwardly of the edge **15** and has a tapped bore **65** which in the clamping position is vertical, as shown in FIG. 7. The bore **65** receives the threaded stem **66** which extends upward from a clamping foot **67**, whose flat bottom surface **68** is presented against a workpiece; the bottom surface **68** extends over that part of the edge **15** which is supported by the bar **11** and preferably part over the table surface *d*.

At each end of the bar **55** outward of a spacer **69** is an operating lever **70** which for clamping is locked in horizontal position of the lever **70**. Illustrated for this purpose is the hooked end **71** of a locking arm **72** pivot mounted to the support *c* by a bolt **73**. Other more sophisticated clamp-locking methods may be used.

The plurality of pads **60** and their ability to be separated from each other and adjustably positioned along the bar **55**, permits accommodation between them of vertical edges of the open end of a sheet metal duct of any convenient width, such as the duct *j* shown in FIGS. 1 and 2 in phantom lines. In use, clamp pads **60** are positioned to fit within the open end of a duct *j* placed on the table surface *d* against the gage *e*. Such a duct *j* is shown fragmentarily in FIG. 8; in FIG. 7 its lower surface *k* is shown as well as its projecting longitudinal edge *m* to be flanged. The operating levers **70** of the clamp mechanism are then moved downward to horizontal position, as shown in FIG. 3, and the hooked ends **71** of the locking arms **72** are engaged thereover, thus setting the clamping feet **67** firmly on the duct lower surface *k* just inwardly of the longitudinal edge *m* and of the greater part of the projection of the forming edge **15** beyond the bar **11**.

The motor *g* is then engaged to cause the chain **24** to draw the carriage **30** in the forming stroke, from left to right in FIG. 1. As it traverses the workpiece edge *m*, the progressive forming rolls **42–46** perform their flanging operations which have been described, starting with the downward bend shown in FIG. 7 and ending with the upward forming of the 180° flange as shown in FIG. 8. During this forming step, the support rolls **50** resist downward deflection of the edge **15** from the forming forces applied by the first two rolls **42, 43** and due to downward inclination of their forming surfaces **42', 43'**.

When the carriage has traveled past the duct *j*, it is stopped and the direction of travel is reversed. This may

be done automatically by familiar micro-switch mechanism when the phantom line position at the right side of the FIG. 1 is reached. On the return stroke, shown in FIG. 9, the supporting rolls **50** perform an entirely different function. Inasmuch as projecting edge **15** is springy, and may deflect upwards to accommodate material of various gages, the 180° flange to which the longitudinal edge *m* has been formed may be accommodated under the surface **17** of the forming edge when the forming rolls **50** are drawn under and along such formed flange. The resistance of the edge **15** against such deflection is however, quite strong; hence, the formed flange on the workpiece edge *m* will be pressed and in effect "ironed out" flat. This removes irregularities, and also tends to eliminate any springback. The resultant 180° flanges are so regular and smooth than conventional flattened C-shaped sheet metal drive cleats may be readily applied over them.

Variations in detailed design, to apply the present invention to modified uses, will be apparent to those skilled in the art. Accordingly, this invention is not to be construed narrowly, but rather as co-extensive with the claims.

What is claimed is:

1. A rectilinear edge flanging tool for sheet metal workpieces and the like, comprising:
- workpiece support structure having
  - a rectilinear forming edge,
- workpiece securing means adjacent thereto,
- the support structure including a surface defining a workpiece support plane in which said forming edge lies,
- the rectilinear forming edge having upper and under surfaces, and projecting blade-like with its upper surface in said support plane and its under surface therebeneath,
- track means parallel therewith,
- carriage means mounted on said track means,
- means to draw the carriage along the track means, and
- forming roll means carried by said carriage means along said forming edge and in workpiece forming adjacency thereto,
- the workpiece securing means including
- a bar pivot-mounted outwardly of the forming edge and parallel thereto and above the level of the track and carriage means,
- a plurality of spaced-apart clamp pads, each having an arm secured to the bar by which said clamp pad is positioned in a clamping position overlaying the support structure along and inwardly of the forming edge,
- means to turn the bar in its pivot mount, whereby to lower the clamp pads to said clamping position and to raise them therefrom, and
- means to secure the bar at the clamping position of said clamp pads.

2. A rectilinear edge flanging tool for sheet metal workpieces and the like, comprising:
- workpiece support structure having
  - a rectilinear forming edge,
- workpiece securing means adjacent thereto,
- the support structure including a surface defining a workpiece support plane in which said forming edge lies,
- the rectilinear forming edge having upper and under surfaces, and projecting blade-like with its upper surface in said support plane and its under surface therebeneath,
- track means parallel therewith,
- carriage means mounted on said track means,
- means to draw the carriage along the track means, and
- forming roll means carried by said carriage means along said forming edge and in workpiece forming adjacency thereto, wherein
- the forming roll means includes a roll having a forming surface of revolution inclined downwardly and outwardly from the forming edge and extending partly above and partly below said support plane, and
- said carriage means further carries means, adjacent to the said forming roll and projecting beneath the under surface of the blade-like forming edge, to support same against downward deflection.

3. A rectilinear edge flanging tool for sheet metal workpieces and the like, comprising:
- workpiece support structure having
  - a rectilinear forming edge,
- workpiece securing means adjacent thereto,
- the support structure including a surface defining a workpiece support plane in which said forming edge lies,
- the rectilinear forming edge having upper and under surfaces, and projecting blade-like with its upper surface in said support plane and its under surface therebeneath,
- track means parallel therewith,
- carriage means mounted on said track means,
- means to draw the carriage along the track means, and
- forming roll means carried by said carriage means along said forming edge and in workpiece forming adjacency thereto, wherein
- the forming roll means includes a roll having a forming surface of revolution inclined downwardly and outwardly from the forming edge and extending partly above and partly below said support, and
- said carriage means further carries an edge support roll on an axis which, when the carriage means is drawn along the track means, defines a plane parallel to and spacedly beneath the under surface of the forming edge,
- whereby to support the blade-like projecting forming edge against deflection caused by the downward inclination of the surface of revolution of the forming roll.

4. A rectilinear edge flanging tool for sheet metal workpieces and the like, comprising:
- workpiece support structure having
  - a rectilinear forming edge,
- workpiece securing means adjacent thereto,
- the support structure including a surface defining a workpiece support plane in which said forming edge lies,
- the rectilinear forming edge having upper and under surfaces, and projecting blade-like with its upper surface in said support plane and its under surface therebeneath,
- track means parallel therewith,
- carriage means mounted on said track means,
- means to draw the carriage along the track means, and
- forming roll means carried by said carriage means along said forming edge and in workpiece forming adjacency thereto, wherein
- the forming roll means comprises
- progressive forming rolls, each supported on an axis which, as the carriage is drawn along the track means, defines a plane substantially perpendicular to the plane of the work support surface,
- one of said progressive forming rolls including a forming surface of revolution inclined downwardly and outwardly from the forming edge and projecting partly above and partly below said support plane,
- whereby to bend a workpiece flange downward, and
- a subsequent forming roll including a forming surface of revolution directed inwardly beneath the undersurface of the projecting forming edge,
- whereby to form the workpiece flange upwardly against the under surface of said forming edge,
- there being on said carriage, adjacent to said first-mentioned forming roll, an edge support roll projecting beneath the forming edge on an axis which, when drawn by the carriage, defines a plane substantially

parallel to and spacedly beneath the under surface of the forming edge,

the means to draw the carriage along the track means including means to effect a return stroke of said carriage along said track means,

whereby the said edge support roll will press the upwardly formed flange tightly against the work forming edge,

the projecting forming edge being characterized by spring-like resilience, whereby to deflect upward on such return stroke and thus accommodate the thickness of such flange between its under surface and the said support roll.

5. An edge flanging tool as defined in claim **4**, together with means mounted on and traversable with said carriage and projecting beneath the under surface of the forming edge to bear against and press a flange, so formed, against said under surface.

6. A rectilinear edge flanging tool for sheet metal workpieces and the like, comprising:

workpiece support structure having

a rectilinear forming edge,

workpiece securing means adjacent thereto,

the support structure including a surface defining a workpiece support plane in which said forming edge lies,

the rectilinear forming edge having upper and under surfaces, and projecting blade-like with its upper surface in said support plane and its under surface therebeneath,

track means parallel therewith,

carriage means mounted on said track means,

means to draw the carriage along the track means, and

forming roll means carried by said carriage means along said forming edge and in workpiece forming adjacency thereto, wherein

said forming roll means comprises a plurality of progressive forming rolls, and

a forming roll subsequent to the first includes a forming surface of revolution directed inwardly beneath the level of the under surface of the forming edge,

whereby, after a flange has been bent downwardly along the edge of a workpiece, to form same upwardly against said under surface.

7. An edge flanging tool as defined in claim **6**, wherein said means to bear against and press the formed flange comprises a roller mounted on an axis which, on movement of the carriage along the track, defines a plane parallel to and below said blade-like projecting edge.

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